

# *Thereuonema tuberculata* (Wood, 1862) (Chilopoda, Scutigeromorpha, Scutigeridae) from forested habitats in North America

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## Abstract

*Thereuonema tuberculata* (Wood, 1862) is an anthropophilic centipede originating from Asia. Introduced populations were recently reported from inside buildings in the United Kingdom and the USA; however, this centipede has not been reported from outdoor habitats where it is an introduced species. We report established populations of *T. tuberculata* in two forested and lakeside habitats in Nebraska, USA, which indicates this species has a widely dispersed, established population in the continental USA.

## Keywords

Centipede, invasive species, Japanese house centipede, Myriapoda, Nebraska, Palearctic, *Scutigera coleoptrata*

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## Introduction

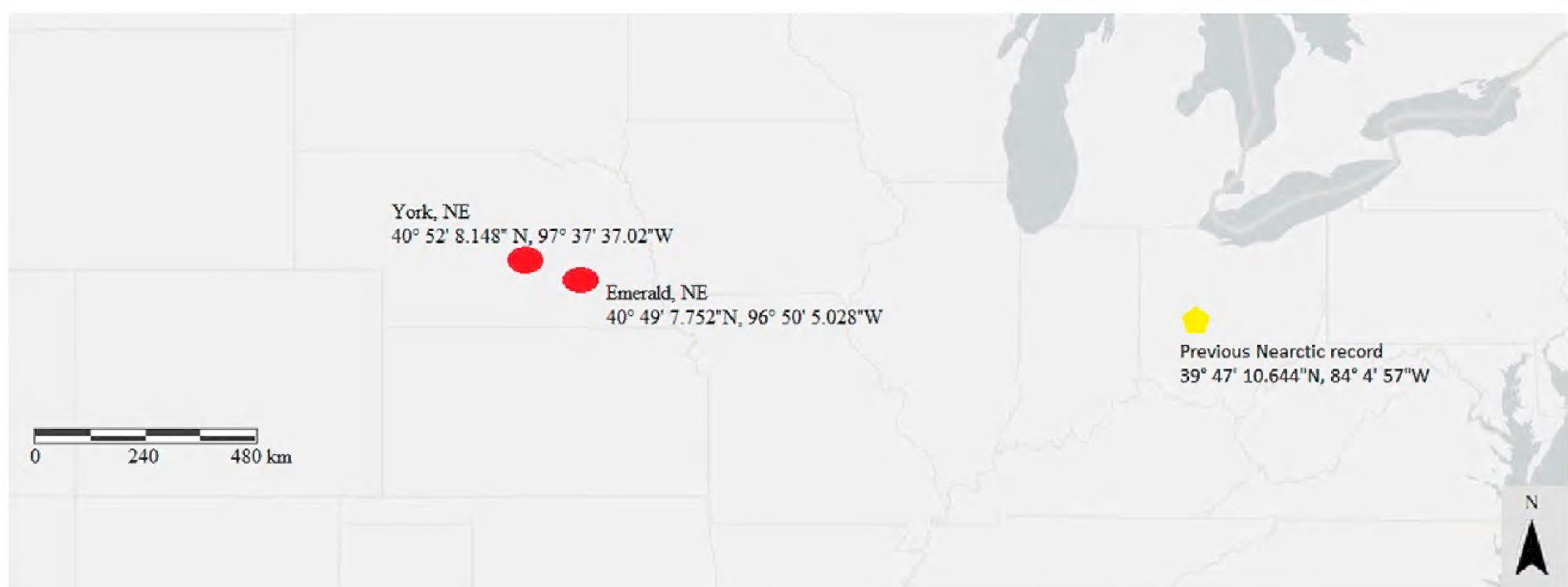
*Thereuonema tuberculata* (Wood, 1862) (Chilopoda, Scutigeromorpha, Scutigeridae) is a Palearctic centipede originating from Asia (Würlmi 1975). It is synanthropic in China and Japan, found on buildings crawling along walls and in small urban gardens or parks, where it presumably is both a scavenger and predator of small invertebrates (Wang 1945; Nakanishi et al. 2015). *Thereuonema tuberculata* was recently reported from inside buildings and warehouses in Swindon, United Kingdom and Ohio, USA (Barber 2011; Reeves 2017); however, it is not known to inhabit outdoors, and the range of this introduced centipede is unclear. As with many Scutigeromorpha, other than the widespread synanthropic species *Scutigera coleoptrata* (Linnaeus, 1758), the basic biology is poorly known and largely undocumented (Lewis 1981).

We report on new geographic records for *T. tuberculata* based on morphology and DNA sequencing and include observations of outdoor populations unassociated with human structures in Nebraska, USA.

## Methods

During field collections of arthropods in Nebraska, USA, numerous scutigeromorph centipedes were observed under rocks and logs near Recharge Lake, York County, Nebraska, USA (40°52'08.15"N, 097°37'37.02"W, 488 m alt.) on 13 September 2021 and along Middle Creek in Emerald, Lancaster County, Nebraska, USA (40°49'07.75"N, 096°50'05.03"W, 366 m alt.) on 14 September 2021 (Fig. 1). These centipedes are fast moving and difficult to collect intact with all of their legs. Three





**Figure 1.** *Thereuonema tuberculata* (Wood, 1862). Orange circles showing new collection records in Nebraska, USA and a yellow pentagon showing the previous reported collection from Ohio, USA.

were captured by spraying them with 70% isopropanol to wet and partially immobilize them before picking them up with forceps and preserving them in 90% isopropanol for field storage. They were subsequently transferred to 99% ethanol for permanent storage to ensure DNA preservation.

Scutigermorph centipedes were initially morphologically identified by microscopy using a regional taxonomic key by Summers (1979). However, the gross morphology of the tergites did not resemble *S. coleoptrata* and were compared to those of *T. tuberculata* as illustrated by Edgecombe and Giribet (2006) and noted by Reeves (2017). To further identify centipedes, the cytochrome oxidase I (COI) gene was sequenced from one immature specimen from Recharge Lake.

An intact centipede was washed in 99% ethanol to remove soil. DNA was extracted with an UltraClean Tissue and Cells DNA Isolation Kit (Beckman Coulter, Brea, CA, USA) following the protocols for tissues as described by Colton et al. (2019). A fragment of the COI gene was amplified by PCR using primers LCO1490 and HCO2198 following the original protocols by Folmer et al. (1994) and later techniques presented by Reynolds et al. (2020). As positive and negative controls, we used a centipede from the same collection expedition, *Scolopendra polymorpha* Wood, 1861, extracted at the same time and distilled water as a negative control.

PCR products were purified using a DNA Clean and Concentrator Kit (Zymo, Irvine, CA, USA), and Sanger sequencing was performed by Azenta Life Sciences (South Plainfield, NJ, USA). The primer sequences were deleted by hand and the remaining sequence were aligned and assembled with ClustalW (Kyoto University Bioinformatics Center, Japan) and compared to sequences in GenBank using the BLAST program (NCBI, Bethesda, MD, USA). A 648-bp COI sequence was submitted to GenBank. A voucher specimen of *T. tuberculata* was deposited in the arthropod collection at the C.P. Gillette Museum (CSUFC), Fort Collins, Colorado, USA.

In addition, the centipedes stored in the C.P. Gillette

Museum, Colorado University Invertebrate Collection (Boulder, CO, USA), Ohio State University Museum of Biological Diversity (Columbus, OH, USA), and Bohart Museum of Entomology (Davis, CA, USA) were examined to see if any additional specimens could be discovered.

## Results

**New records** (Fig. 1). UNITED STATES OF AMERICA – **Nebraska** • York County; Recharge Lake; 40° 52'08.2"N, 097°37'37.0"W, 488 m alt.; 13.IX.2021; W.K. Reeves leg.; hand collection; 3 immature, in 95% ethanol (CSUFC) and GenBank accession # OM363186 • Lancaster County; Emerald; Middle Creek; 40°49'07.8"N, 096°50'05.0"W, 366 m alt.; 14.IX.2021; W.K. Reeves leg.; hand collection; 1 ♀, specimen destroyed.

**Identification.** Microscopic examination of the tergites of all specimens had spiculae (hair-like or needle-like spines) as per Bonato et al. (2010), which is a morphological character that separates *Thereuonema* and *Scutigera* (see Edgecombe and Giribet 2006).

Positive and negative PCR controls worked as expected. The DNA sequence for the COI gene was a 99% match to that of a *T. tuberculata* (GenBank accession # DQ222173) with the predicted amino acid translation being 100% identical to that of a specimen from Japan submitted by Edgecombe and Giribet (2006) (accession # ABB55472) and it was not identical to all other fully identified species in GenBank.

There were no additional specimens of *T. tuberculata* from the museums that we investigated, with the exception of a specimen at the Bohart Museum collected in Japan.

## Discussion

We discovered populations of *Thereuonema tuberculata* (Fig. 2) in rural habitats in Nebraska that are approximately 70 km from each other and 1200 km from the





**Figure 2.** *Thereuonema tuberculata* (Wood, 1862) (Scutigermorpha, Scutigerae). Photograph by D. Daley of a temporarily mounted specimen collected from Recharge Lake, York Co, Nebraska, USA (40°52'08.2"N, 097°37'37.0"W, 488 m alt.) on 13 September 2021.

previously reported records of this species from buildings in Ohio (Reeves 2017; Fig. 1). Our detection of outdoor populations in forested or lakeside habitats indicate that *T. tuberculata* is established in the continental USA and collections from buildings in Ohio do not represent a transient population from buildings. Identifications of *S. coleoptrata* from the USA are suspect until the range of *T. tuberculata* is known along with the history of its introduction. The other genus of Scutigermorpha in the USA is *Scutigera*, with the exception of *Allothereua*, *Dendrothereua*, and an unnamed Thereuoneminae from Hawaii and Guam (Mercurio 2010; Giribet and Edgecombe 2013).

The wild population of *T. tuberculata* at Recharge Lake outside of York appeared numerous with more than 10 centipedes observed in a 30-minute collecting time-frame. Many rocks or woody debris around the lakeshore had one or more centipede living under them. Fewer *T.*

*tuberculata* were found in Emerald, and these were collected on water-saturated woody debris and rocks just above waterline of Middle Creek. The roles that these active predatory and scavenging arthropods are playing in the ecosystem are unknown. Presumably these centipedes are competing with others in the same ecosystem and possibly serving as the hosts and reservoirs to exotic parasites such as *Trichorhynchus pulcher* Schneider, 1882 (Eugregarinida, Trichorhynchidae), a parasitic protozoan of this and other scutigermorph centipedes (Devetak et al. 2019). These records indicate a need for further sampling and evaluation of Scutigermorpha from North America.

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## Authors' Contributions

Conceptualization: WR. Data curation: WR, MM. Formal analysis: WR, MM. Funding acquisition: MM. Investigation: WR, MM. Methodology: MM, WR. Project administration: WR. Resources: MM. Software: WR, MM. Validation: MM. Writing – original draft: WR. Writing – review and editing: MM.

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